

CASE REPORT

Porcelain Factory Worker With Asbestos-related Mesothelioma

Meng-Ting Tsou,^{1,2} Jiin-Chyuan J. Luo^{3,4*}

Malignant mesothelioma is a rare tumor among the general population, but for people exposed to asbestos, the lifetime risk is high. A 58-year old man presented with suffering from chest pain, upper back pain, shortness of breath, and coughing that had continued for several months. A chest X-ray revealed right-side pleural effusion; however, pleural biopsy from drainage treatment confirmed a diagnosis of malignant mesothelioma. According to his occupational and environmental history, the patient had worked continuously in a porcelain factory for 30 years. The specific characteristics of his work, making asbestos wallboards and gaskets, entailed working in high-temperature conditions with a high fine-particle content in the atmosphere. The high working temperature caused asbestos debris and dust to fall down regularly from the wallboards, however, it was not until recently that the patient had started to wear personal protection. Asbestos is a significant source of hazardous exposure in old buildings, and this case serves as a reminder of the importance of asbestos-related exposure history, which facilitated the correct diagnosis of pulmonary malignant mesothelioma. Asbestos-containing materials that are now banned or regulated are still present in older buildings and remain an exposure hazard; they continue to be a serious health concern in many countries. [*J Formos Med Assoc* 2009;108(10):819–825]

Key Words: asbestos, mesothelioma, occupational exposure

Malignant mesothelioma is a very rare form of cancer. Its unique association with asbestos was confirmed by Wagner et al in 1950.¹ For people who have been exposed to asbestos, the lifetime risk for developing mesothelioma is high. Generally, it takes 20–60 years for mesothelioma to develop, with an average latency period of 30 years. The prognosis is generally very poor and death usually occurs within 1–2 years after diagnosis, although longer survival rates have been documented.²

Most cases of asbestos diseases have a strong exposure history, but some develop after only minimal exposure. There is a long latent period between exposure to asbestos and development

of disease; therefore, even in countries like the United States where asbestos exposure is now regulated and reduced from previous levels, these diseases still exist.² The main reason is that asbestos is still used in some products, although the risk of using these products must be clearly labeled. In the past, it was used in the construction of many buildings, including houses, offices and schools. It is estimated that 10–15% of schools in the United States still contain asbestos.³ For reasons like these, asbestos exposure is still possible in the home, work place, or at school.

There have been only a few studies on the relationship between asbestos-related lung diseases, occupation and the environment in Taiwan.

©2009 Elsevier & Formosan Medical Association



ELSEVIER

¹Department of Family Physicians, Mackay Memorial Hospital and ²Mackay Medicine, Nursing and Management College, Taipei, and ³Department of Occupational Medicine, Chang Gung Memorial Hospital, and ⁴Chang Gung University, Taoyuan, Taiwan.

Received: November 28, 2007

Revised: February 27, 2008

Accepted: March 28, 2008

*Correspondence to: Dr Jiin-Chyuan J. Luo, Department of Occupational Medicine, Chang Gung Memorial Hospital, 5 Fu Hsing Street, Kuei Shan, Taoyuan, Taiwan.
E-mail: lao5485@mail.cgu.edu.tw

Chen et al conducted a cross-sectional health survey of 459 workers in 33 asbestos-related factories in Taiwan in 1992.⁴ The workers had an average of 8.1 years of dust exposure, with a range of 1–42 years. No case of asbestos-related lung disease was found during this investigation. We et al screened for respiratory disorders among shipbuilding workers in two factories in Northern Taiwan in 1998.⁵ The results showed that the prevalence of pneumoconiosis was 2.8% (26 cases), tuberculosis (TB) was 2.4% (22 cases), and pleural thickening was 0.4% (4 cases). However, no asbestos-related lung disease was found in this study. Chang et al surveyed > 20,000 residents who lived near 41 asbestos factories in Taiwan in 1999, and showed that the numbers of expected excess deaths from lung cancer and mesothelioma were five and less than one, respectively.⁶ During 1990–1998, only four cases of asbestosis, but none of mesothelioma were reported in our country, which was less than in other industrialized countries.⁵

The present case serves as a reminder of the importance of a history of asbestos-related environmental exposure, and the availability of a complete history in this type of patient can facilitate the correct diagnosis of pulmonary malignant mesothelioma. This is a case report of environmental asbestos exposure that induced mesothelioma in Taiwan.

Case Report

Symptoms of dyspnea, right chest pain and upper back pain began to appear in this 58-year-old man in May 2005. A chest X-ray (CXR), which was carried out at a medical center in September 2005, led to a diagnosis of right-side pleural effusion (suspected TB), and the patient agreed to tube drainage and anti-TB drug treatment. However, following the removal of the accumulated fluid, a pleural change was discovered. A pleural biopsy showed pathological features of papillary mesothelioma but no asbestos fibers were found. The results of CXR and computed tomography (CT) (September 2005) are presented in Figure 1.

This patient had worked in a porcelain factory for 30 years since 1975. In this factory, titanium dioxide and aluminum oxide powder were mixed with old recycled china, and ground in water to produce a semi-solid material. Under high-temperature conditions, the semi-solid material was transformed subsequently into powder form again. Although there was a high powder content within this working environment, the patient did not wear any kind of respiratory protective equipment during the working day. The patient was exposed to this environment for 8–10 hours/day, 5 days/week, for a period of 30 years. The workplace was a very old building that had not been repaired for almost 30 years, and according to the

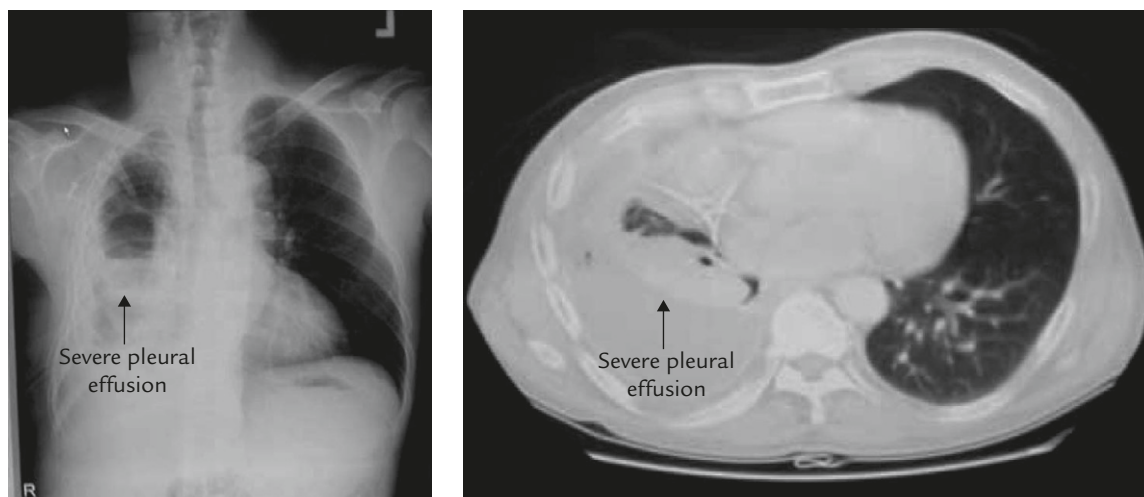


Figure 1. Chest X-ray and computed tomography results in September 2005.

patient's own description, the high working temperature caused asbestos debris and dust to fall down regularly from the wallboards (Figure 2).

He lived with his children and wife, whose job did not involve contact with asbestos, in a 30-year-old apartment that had been renovated in 1977, 1990 and 2002. Before the patient joined the china factory, his previous physical examination reports were normal. Unfortunately, he did not have the opportunity to receive periodic health examinations after that. There was no other discomfort until 2004, when he began to show symptoms of mild cough. As a result, in May

2004, he visited another medical center to undergo a general physical checkup. According to the CXR report, partial pleural thickening was noted and asbestos-related lung disease was indicated (Figure 3). CT was carried out in September 2005 and revealed heavy pleural effusion with further asbestos-related lesions in other parts of the lungs (Figure 4). The final diagnosis of papillary mesothelioma was confirmed by pleural tissue biopsy.

Discussion

Asbestos is strong, lightweight, resistant to chemical destruction and fireproof, and is a heat and electrical insulator. Potential sources of asbestos exposure can be found everywhere. However, the greatest rates of exposure are generally occupational. Numerous industries have an asbestos-rich working environment.⁷ Table 1 shows the potential sources of occupational and environmental asbestos exposure.^{8–12} In Taiwan, the industries with the largest numbers of workers exposed to asbestos are cement production, building demolition, ship breaking, and production of brake linings and clutch pads.¹³

Non-occupational exposure to asbestos is also a health risk. A significant source of environmental exposure is in public buildings. Asbestos-containing materials that are now banned or regulated are still present in old buildings and



Figure 2. Workplace environment.

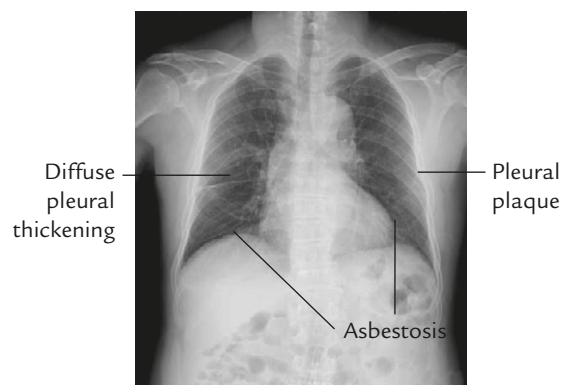


Figure 3. Early signs of mesothelioma shown on chest X-ray in May 2004.

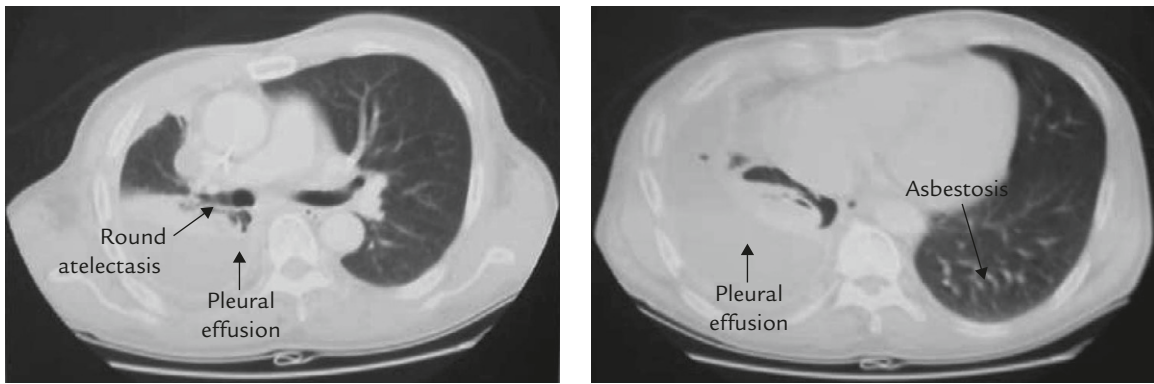


Figure 4. Computed tomography in September 2005.

Table 1.	Potential sources of occupational and environmental asbestos exposure ^{8–12}
Asbestos-containing products	
Asbestos-containing flight materials: exposed workers may include aircraft mechanics and those involved in aerospace and missile production and aircraft manufacturing	
Asbestos-lined electrical products: exposed workers may include electrical workers (e.g. electricians), electrical linesmen, telephone linesmen, and power plant workers	
Asbestos shipping materials: exposed workers may include shipyard workers (e.g. insulators, ladders, painters, pipe fitters, maintenance workers, and welders), Coast Guard personnel, merchant mariners, longshoremen, United States Navy personnel, asbestos manufacturing plant workers, insulators, machinists, persons working at packing and gasket manufacturing plants, pipe fitters, and power plant workers	
Brake linings and clutch pads: exposed workers may include car mechanics, those involved in brake and clutch manufacture, and assembly workers	
Building materials: exposed workers may include building engineers, cement plant workers, building material manufacturers, construction workers (including insulators, boilermakers, steelworkers, ironworkers, plumbers, steamfitters, plasterers, dry-wallers, cement and masonry workers, roofers, tile/linoleum installers, carpenters, and welders)	
Other asbestos-containing products: exposed workers may include railroad workers, steamfitters, refinery workers, sheet metal workers, refractory products plant workers, rubber workers, and warehouse workers	
Asbestos removal	
Removal of insulation, asbestos removal, and waste handling	
Building demolition and ship breaking	
Environmental exposure	
Asbestos in public buildings (e.g. hospitals, libraries, schools); occurs when the asbestos is disturbed during building or maintenance work	
Family members of persons exposed occupationally	
Asbestos production	
Asbestos mining; textile mill workers who weave asbestos into cloth	
Asbestos transport	
Packing and handling of asbestos	

remain an exposure hazard. During maintenance, repair, demolition or renovation, asbestos fibers may be released, putting building occupants or passers-by at risk.¹⁴ The level of asbestos

inside old buildings with asbestos ceiling materials can be 100 times higher than that in the air outside, although usually it remains three or four orders of magnitude lower than the workplace

Table 2. Symptoms and treatment of asbestos-related lung diseases⁸

Disease	Presenting symptoms	Treatment
Asbestosis	Dyspnea, dry cough	No specific therapy; surveillance for lung cancer; smoking cessation
Lung cancer	Chest pain, cough, dyspnea, hemoptysis, weight loss, fatigue, symptoms caused by metastases and direct invasion	Multimodality treatment including surgery, radiotherapy, and chemotherapy
Mesothelioma	Chest pain, cough, dyspnea, weight loss, fatigue, pleural effusion, symptoms caused by metastases, pericardial invasion, esophageal compression, superior vena cava invasion	Multidisciplinary approach focused on supportive care; multimodality treatment including surgery, radiotherapy, and chemotherapy (clinical trials ongoing); radiotherapy for localized pain and metastatic spread occurring along a biopsy tract; chemical or surgical pleurodesis for pleural effusion
Pleural plaques	Usually asymptomatic, incidental finding on chest radiography; may cause grating sensation associated with calcified plaques	Smoking cessation; withdrawal from further exposure; management of concurrent and other respiratory diseases

levels that are associated with well-documented occupational disease.¹⁴ It is hard to quantify the health effects of these elevated asbestos levels, particularly because it can take such a long time for disease to develop following exposure.

Information about asbestos hazards has been discussed in many fields. No studies on animal or human disease have described the acute toxicity of asbestos.^{15,16} Chronic inhalation exposure to asbestos in humans can lead to asbestos-related lung disease. A substantial number of occupational studies have reported that exposure to asbestos by means of inhalation can lead to lung cancer and mesothelioma.^{15,16} In particular, individuals who have a smoking habit and concomitant exposure to asbestos have an additional risk of developing lung cancer.¹⁵ Several occupational studies have reported an increase in gastrointestinal cancer from exposure to asbestos through inhalation and subsequent oral ingestion.^{15,16} Table 2 shows the symptoms and treatment of asbestos-related lung diseases.⁸

The United States Environmental Protection Agency (EPA) considers asbestos to be a human

carcinogen, ranking it as a Group A substance. The EPA uses mathematical models based on human and animal studies to estimate the probability of a person developing cancer from breathing air that contains a specified concentration of certain substances, from which an inhalation unit risk of 2.3×10^{-1} fibers/cm³ is estimated.¹⁷ The United States Occupational Safety and Health Administration sets a maximum exposure limit for construction workers and others working with asbestos. Workplace exposure must be limited to 0.1 fibers/cm³ of air averaged over an 8-hour work shift (Threshold Limit Value–Time Weighted Average; TLV–TWA). For short-term exposure, the limit is 1 fiber/cm³ of air averaged over a 30-minute time span.¹⁴

According to a study in Taiwan, the cement industry has diminished gradually, and the TLV–TWA in these factories was under that recommended by our government (1 fiber/cm³) in a 1995 environmental asbestos concentration survey. The brake linings and clutch pads industry is continuing to develop in Taiwan. However, about 28% of these factories had an asbestos concentration

Table 3. Diagnostic criteria for asbestos-related lung disease¹⁸

Major criteria

1. Occupational or environmental exposure history
2. Duration of first exposure until disease attack (> 5 yr)
3. Clinical medical evidence, at least 3 of the following:
 - a. CXR: small irregular: s, t, u*; extended: more than 1/1[†]
 - b. FVC < 80% predictive value
 - c. DLco < 80% predictive value
 - d. End-inspiratory basilar rales, with sound persisting after patient cough
4. Exclusion of other non-asbestos etiology

Criteria for further evaluation

1. Chest CT scan
2. Gallium scan
3. Bronchoalveolar lavage
4. Lung biopsy
5. Asbestos concentration in workplace

**Irregular small opacities are classified by width: s (up to 1.5 mm), t (1.5–3.0 mm) or u (3–10 mm); †perfusion (frequency) of small opacities is classified on a 4-point major category scale (0–3). CXR = chest X-ray; FVC = forced vital capacity; DLco = diffusing capacity of the lung for carbon monoxide; CT = computed tomography.*

> 1 fiber/cm³ in a 1995 survey. In a 1996 industrial survey, the result improved, but still 5% of air samples had more than 1 fiber/cm³, and about 12% had 0.5–1.0 fiber/cm³. Even today in Taiwan, there are still many old buildings that have cement siding, high-temperature gaskets and wallboards, which contain many asbestos fibers.¹³

The diagnostic criteria for asbestos-related lung disease according to labor law in Taiwan are shown in Table 3.¹⁸ The principles that underpin the diagnosis of occupational–environmental diseases essentially comprise five main parts: (1) evidence of disease; (2) evidence of occupational or environmental exposure; (3) confirmation of succession according to the principle of initial exposure to the hazard, followed by development of the disease; (4) confirmation of existing evidence in human epidemiology; and (5) removal of all other possible pathogenic factors.

The 58-year-old male patient described in this case report had mesothelioma that was confirmed by clinical progression and pathological data. The concentration of asbestos fibers in the air at the factory was difficult to determine because the manager had switched from asbestos wallboards to iron-material wallboards and gaskets. An old picture of the factory, however, shows that

asbestos wallboards and gaskets had been used previously. The high working temperature had caused asbestos debris and dust to fall down regularly from the wallboards. According to the serial CXR and CT films, asbestos-related lung disease was diagnosed at the time of the patient's general physical checkup in 2004. The diagnosis was changed subsequently to malignant mesothelioma in 2005. There is still insufficient evidence of any other factors that might have been responsible for the patient's malignant mesothelioma.

There is no evidence of a safe level of asbestos from which there is no risk of mesothelioma. There might be a background level of mesothelioma that occurs in the absence of exposure to asbestos, but there is no proof of this, and this natural level is probably much lower than the oft cited 1–2 people a year who get mesothelioma out of every 1 million people who are exposed to asbestos.¹⁹ One case report in 2000 describes a 46-year-old woman who was dying from histologically confirmed diffuse malignant mesothelioma after asbestos exposure, which was only caused by indoor exposure to crocidolite-containing spray asbestos in building materials. She had no other known occupational asbestos exposure during her life time.²⁰ Many recent studies have

provided strong evidence that asbestos pollution from an industrial source greatly increases the risk of mesothelioma. Furthermore, relative risks from occupational exposure have been underestimated and have increased markedly when adjusted for residential distance.²¹ The current findings suggest that environmental asbestos exposure continues to be a serious health concern in many countries, such as Turkey.²²

Asbestos exposure affects asbestos workers and their families, users of asbestos products, and the general public who are exposed to building materials in their homes and public buildings. Internationally, the World Health Organization and the International Labor Organization are responsible for occupational and environmental health and safety.²³ Taiwan should strengthen asbestos-control programs to ensure the safety of those who work in high-risk industries or live in asbestos-containing buildings.

Acknowledgments

This study was supported by grants from the Chang Gung Medical Center (NSC 85-2331-B-182-106) and the National Science Council in Taiwan (NSC 95-2314-B-182A-054-MY2, NSC 95-2314-B-182-054-MY2).

References

- Wagner JC, Munday DE, Harrington JS. Histochemical demonstration of hyaluronic acid in pleural mesothelioma. *J Pathol Bacteriol* 1962;84:73–8.
- Cunha JP. *Asbestos-related Disorders*. Available at http://www.medicinenet.com/asbestos-related_disorders/article.htm [Date accessed: January 2007]
- United States Environmental Protection Agency. *Asbestos and Vermiculite*. Available at http://www.epa.gov/asbestos/pubs/asbestos_in_schools.html [Date accessed: November 2007]
- Chen CR, Chang HY, Suo J, et al. Occupational exposure and respiratory morbidity among asbestos workers in Taiwan. *J Formos Med Assoc* 1992;91:1138–42.
- We TN, Shu CC, Chang SF, et al. Screening program of asbestosis among shipbuilding industry. *Chin J Occup Med* 1998;5:31–8.
- Chang HY, Chen CR, Wang JD. Risk assessment of lung cancer and mesothelioma in people living near asbestos-related factories in Taiwan. *Arch Environ Health* 1999;54:194–201.
- Noonan C, Pfau JC, Larson TC, et al. Nested case-control study of autoimmune disease in an asbestos-exposed population. *Environ Health Perspect* 2006;114:1243–7.
- O'Reilly KMA, McLaughlin AM, Beckett WS, et al. Asbestos-related lung disease. *Am Fam Physician* 2007;75:683–8.
- Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health. *Work-related Lung Disease Surveillance Report 2002*. Cincinnati: National Institute for Occupational Safety and Health, May 2003.
- Centers for Disease Control and Prevention. Changing patterns of pneumoconiosis mortality: United States, 1968–2000. *Morb Mortal Wkly Rep* 2004;53:627–32.
- Price B, Ware A. Mesothelioma trends in the United States: an update based on Surveillance, Epidemiology, and End Results Program data for 1973 through 2003. *Am J Epidemiol* 2004;159:107–12.
- Lilienfeld DE, Mandel JS, Coin P, et al. Projection of asbestos related diseases in the United States, 1985–2009. *Br J Ind Med* 1988;45:283–91.
- Available at <http://www.iosh.gov.tw/data/f2/sp30-4.htm> [Date accessed: October 2006]
- Sullivan P. Vermiculite, respiratory disease, and asbestos exposure in Libby, Montana: update of a cohort mortality study. *Environ Health Perspect* 2007;115:579–85.
- Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Asbestos* (Draft). Atlanta: U.S. Department of Health and Human Services, 1995.
- United States Department of Health and Human Services. *Hazardous Substances Data Bank*. Bethesda: National Toxicology Information Program, National Library of Medicine, 1993.
- United States Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Asbestos*. Available at <http://www.epa.gov/iris/subst/0371.htm> [Date accessed: November 2005]
- ILO Classification*. Available at <http://www.cdc.gov/niosh/topics/chestradiography/breader-list.html> [Date accessed: February 2007]
- Hillerdal G. Mesothelioma: cases associated with non-occupational and low dose exposures. *Occup Environ Med* 1999;56:505–13.
- Schneider J, Rödelersperger K, Brückel B, et al. Pleural mesothelioma associated with indoor pollution of asbestos. *Occup Environ Med* 2000;56:505–13.
- Maule MM, Magnani C, Dalmaso P, et al. Modeling mesothelioma risk associated with environmental asbestos exposure. *Environ Health Perspect* 2007;115:1066–71.
- Osman E, Hasan B, Meral U, et al. Recent discovery of an old disease: malignant pleural mesothelioma in a village in south-east Turkey. *Respirology* 2007;12:448–51.
- LaDou J. The asbestos cancer epidemic. *Environ Health Perspect* 2004;112:285–90.